THE SYMBOLIC CAPACITY

- IRRUPTION WITH AN EMERGING FORM OF THE SYMBOLIC-VERBAL CAPACITY IN CHILDHOOD DEVELOPMENT, AND THE LEARNING CAPACITY IN MACHINES

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- List of Acronyms at the end.

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SUMMARY

The verbal irruption of vocabulary, with accelerated learning of symbolic verbal representations, and in everyday speech, occurs in infant-children in the process of their development. This begins around 18 months with the distinction that is made of the symbol with respect to the represented object (DeLohache, 2005). The symbolic faculty also appears in animals, which is represented by mimicry, camouflage, courtship and the ability to show or receive threat (challenging posture, mouth showing teeth and other signs) before the fight. And it is manifested both by the territory, and by the pairing, or / and in times of rut; already in itself, it is a remarkable process of symbolization, although it is instinctive (without new learning, and produced in basic behaviors of the species). On the other hand, Rascorla & Wagner, establish from animal behavior, how representational learning of advantageous behavior is carried out in an environment with controlled parameters equivalent to survival, and that can become general to the human process itself. On the other hand, we are probably witnessing the appearance of similar functionality in computer machines and systems.

Key terms: emergency process, verbal irruption, symbolic capacity, learning curve, new mental state, cognitive representations, new words, sensory images, information processing, simple and complex computer program, complexity theory.

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Introduction

Verbal irruption occurs in baby-children from 18 to 36 months in the development process, beginning with the distinction of the symbol from the represented object[2] (DeLohache, 2005). In another way but also the symbolic faculty in animals is represented and present in the mimicry, camouflage, courtship and gestures-expressions of threat before the fight for the territory, or for the mating in times of rut, being a process remarkable, and on the other hand, purely instinctive.

Rascorla & Wagner (RW), establish for animal behavior a recognized model of how representational learning is established in a controlled environment (R. Morris, 1981), later becoming general to the human process itself (V. Chamizo, 2003) ; on the other hand we see that in the period of verbal irruption in children, it manifests itself following a similar but more abrupt function, as it is emergent.

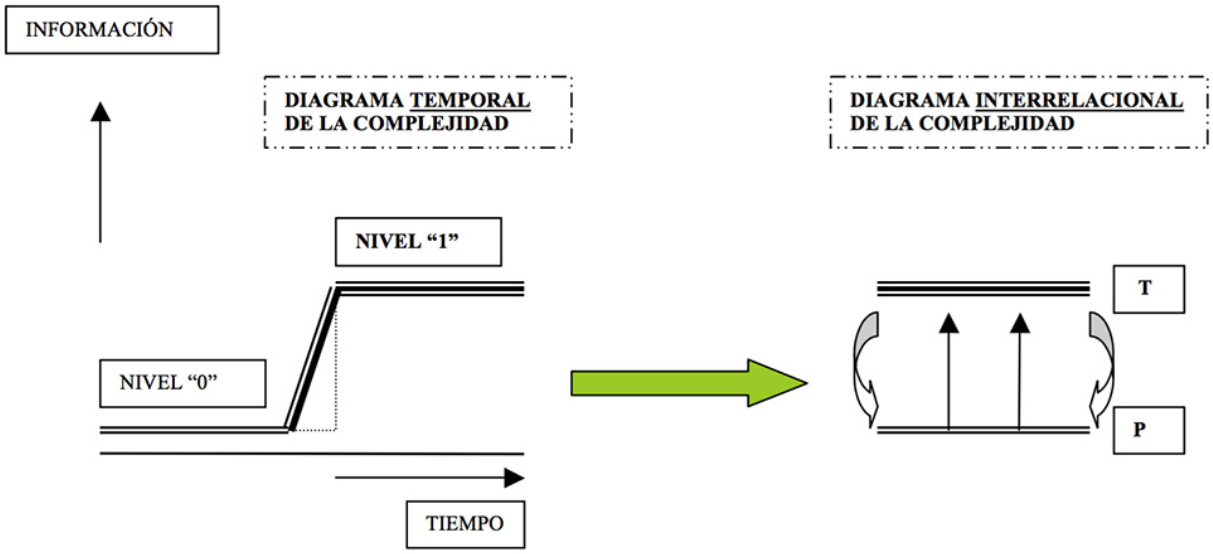
This sudden verbal irruption, typified in all the analyzes of the development of children, is supported by the entire genetic and epigenetic apparatus in which we are settled as human beings, and which, on the other hand, fosters and supports in its interpretation, the framework of the theory. of N. Chomsky's Universal or Generative Grammar Law for language and, of course, directly in the first place, from genetics (J. Sanpedro, 2002)[3]; language plausibly provides the symbolic capacity for learning the first use of language in the child's development process, especially in the so-called <critical period> (as demonstrated by the study of <wild children>, for example by Victor de Aveyron (1799), who have not had immersion in a human environment during the first years of life). In this way we understand that, more than <an instinct for language> (S. Pinker, 1994), it is more precisely that there is an instinctive disposition; of an **<instinct to learn a language>** (R. Burling[4], 2007), which is something different and relevant.

The functional curve of any learning is widely recognized and established, but here we are going to base, for expository, understandable and generalization purposes, the starting point of the RW model, and to explain it, the formula and curve deduced from its model are explained, as a formulation and synthetic idea of it.
The memory studies of Ebinghauss and other learning experts, such as those in the area of learning in ergonomics and labor production, as well as in general in economics, are equally valid representations of the same ability, which are feasible to expose in an equivalent way and essentially coincident, coming from the same fund of the model, with the capture and incorporation of information from the environment; specifically with the synthesis analysis of the sigmoid-logistic curve, in partial or complete version, which is generically referenced here, and is deduced from the RW theory as a unit.

In the exposition that follows, a double intention will be developed that is made explicit, the first, (1) to show how the shape and variations of said curve is not at all enigmatic, and belongs to a statistical spectrum of network theory, which as a Terms knowledge network, for example, is created in this case throughout the learning process and when added term by term. Erdös and Renyi, developed by graph theory, how these networks propagate and create (for example for a rumor, an epidemic, arise from the necessary steps of contacts between people with a format called "small world", or more simply occurs similarly for an "threads and buttons network[5]" as an example, and you can also experiment with "threads and clips" (equivalently, even more easily, transferred to a similar time coordinate). The second intention (2) is to differentiate the step of a normal learning of gradual growth always proportional, and to distinguish it from the one that occurs in an emergent system (in Scheme 1 below, the figure on the left is

[2] Jean Piaget's analyzes with The language and thought in the child (1924), The representation of the world in the child (1926), The formation of the symbol in the child (1946), advocate the symbol constructively and the symbolic function, but not enter the analysis of the neuropsychological functional mechanism of <symbolic capacity>
[3] Sampedro, Javier (2002). *Deconstruyendo a Darwin*. Editorial Crítica
[4] Burling, Robbins, 2005. The Talking Ape. Oxford University Press
[5] Kauffman, Stuart (2000). *Investigations*. Oxford University Press

a simplification, that of a pseudosigmoid ramp), like that of <verbal irruption>, and which leads us to a new mental state in the baby-child, by acquiring symbolic capacity, which is especially shown by the verbal articulation, which arises at a rhythm or considerably high speed, for doing it in a pre-existing neural network, and that during its childhood development it was never so strongly before, nor will it be after acquiring that capacity shown in particular with the enrichment of vocabulary. Below, in the same Scheme 1, belonging to the complexity theory, the scheme on the right is shown, which was indicated by Chris Langton[6], and described by R. Lewin (1992), giving us a schematic image of the interrelation TD (top-down) and BU (botton-up), of a complex relationship between two levels T (whole) and P (parts),



Scheme 1

Symbolic acquisition is qualitatively well illustrated, for example, in the casuistry of the case of the deaf and muteblind Hellen Keller (HK) and Marie Hourtin, who revealed this experience and the new state of mind learned, and which has been related and taken to the cinema with Oscar included. The testimony of HK and his teacher[7], who describe it separately, is especially descriptive; specifically, how this new state of

[6] Lewin, Roger (1992). *Complejidad*. Edit. Tusquets-Metatemas

[7] It is April 5, 1887, Hellen Keller's tutor-teacher writes: "This morning, while she was washing, she wanted to know how to say water. When she wants to know the name of something, she points to it and pats my hand. I spelled it and didn't think about it until after breakfast. Then it occurred to me that with the help of that new word I could solve the water-cup confusion. We went to the fountain, and I had Helen hold her mug under the stream as I pumped. As cool water gushed out filling the cup, I spelled "w-a-t-e-r" in Hellen's free hand. The close proximity between word and the sensation of the cold water jet in her hand seemed to startle her. Hellen dropped the cup and was transfigured. A new light illuminated his face. He spelled water several times. Then she threw herself on the ground and asked me her name and pointed to the pump and gazebo, and suddenly she turned to ask me by name. I spelled <master>. Then the babysitter brought in Hellen's little sister and Hellen spelled <Baby> and pointed at the babysitter. During the return home she was very excited, and she learned the name of each object she touched, so in a few hours she had added thirty new words to her vocabulary ". Annie Mansfield Sullivan (1866-1936).

On the other hand, Hellen Keller, older, wrote about these events: "One day while I was playing with my new doll, Miss Sullivan put my big rag doll on my lap, I spelled it out and tried to make me understand that this word is applied to both wrists. That day we had a quarrel over the words "c-u-p" and " w-a-t-e-r ". Miss Sullivan had tried to make me understand that " c-u-p " was cup and " w-a-t-e-r " was water, but I insisted on confusing the two. She had chosen to leave that topic for a while, to pick it up again at the first opportunity. Impatient at her repeated attempts, and taking the new doll, I threw it to the ground. I was delighted to feel the fragments of the broken wrist at my feet. My outburst of anger was not followed by regret or regret. I did not love that doll. In the silent and dark world where I lived there were no strong feelings, no tenderness. I noticed that my teacher was sweeping the fragments off to the side of the home, and I was pleased to have eliminated the cause of my discomfort. She

mental processes is experienced and produced, undoubtedly special, and to which in fact the "wild children" have been unable to access due to lack of an adequate environment.
The mental representations, fruit of the new state of cognition, are not only verbal, they are also produced with sensory images. This verbal and image code is dual but unified as representation, and both obey the process of symbolization.

A good exponent of this set itself is the dual model of symbolization by A. Paivio (1971-2008); This typified it in those two aspects (verbal use and sensory images), and demonstrated the importance of both codes when faced with the presentation of stimuli, producing sensations and perceptions; They have been collected in the psychological analyzes of the expression of mental function that have been carried out during two final decades of the s. XX and early s. XXI by this psychologist and related teams. This identification is important, because it establishes two types of symbolization, which classical psychology in the representation management test, as well as neuroscience, have subsequently analyzed and verified its relevance (the latter for example, and among other tests and authors, using the Vividness Visual Imaging Questionary –VVIQ-, contrasted by scanning with fRMI in the Egleman Lab, 2007[8]).

This psychological, internal and symbolic world is also currently being emulated on machines at a limited level, but very close to human processing, by Artificial Intelligence (AI) technology.
Symbolic capacity is determining as cognitive capacity, because it is preliminary with respect to intelligence. For example, linguistic intelligence begins to unfold with new vocabulary, but previously there has been a prelinguistic or presymbolic phase in the infant-child, as mentioned. Similarly, the determination of the maturity window for the symbolic process; for example, in which a real apple is preferred to a photographed apple, which shows an interest in the object “in itself”, rather than in a representation, being an indicator of maturity in the preference for the source object of the representations , much more realistic than the 2D figure, however reliable it may be; We could also allude to the multisensory aspect of the "apple" object that the photo does not have, because in addition to its relief, it smells, and even tastes if bitten.

The definition of "symbol" illustrates the level of abstraction, by substituting entities for each other. Abstraction is a characteristic of intelligence, and is shown as an important nucleus of it. The analog-digital discussion, carried out by P. Rocchi (2012)[9], shows how it is rooted in the symbolic with signal detection and information processing, which is the basis of cognition, and therefore of intelligence, not only from organisms and biological observers, but also in the instruments and devices of physics and technology, such as Rocchi's reference.

The relevance of such a situation is given by the fact that the mechanism described is explained phenomenologically, but may also be able to perform itself artificially, experimentally, and control its function (symbolic capacity, in this case).

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brought me the hat, and I knew it would come out in the warm sunlight. This thought - if a wordless sensation can be called thought - made me jump with pleasure.
We walked along the path to the fountain, attracted by the fragrance of honeysuckle that covered it. Someone was drawing water and my teacher put my hand under the tap. As the cool stream soaked through one hand, she spelled the word <water> in the other, first slowly, then hurriedly. I was silent, fixing my attention on the movement of her fingers. Suddenly I had a blurred consciousness, like something forgotten, the shudder of a thought that returned; and somehow the mystery of language was revealed to me. I knew then that " w-a-t-e-r " meant that wonderful freshness that touched my hand. That living word woke up my soul, gave it light, hope, joy, released it. There were still barriers, it's true, but barriers that could be removed over time. " Hellen Keller (1880–1968).

[8] Cui, Xu, et al. & Eagleman Lab. (2007). *Vividness of mental imagery: Individual variability can be measured objectively*. ScienceDirect-Elsevier

[9] Rocchi, P. (2012). *Logic of analog and digital Machines. IBM*

Scientists like Feyman (1968)[10] explain how the probity of a theory, or the good description of a system when it is explained, makes it depend on its equivalent empirical contrast in experimentally developed functions), if this occurs, Feyman says, is that scientifically it is controllable and its operational knowledge is thus demonstrated, thus also having the capacity for its possible reproducibility.

AI[11], with symbolic <top down> (TD) techniques, from expert computer systems (for example IBM's Deep-Blue and Watson computer systems), and / or with sub-symbolic <botton up> (BU) techniques, of deep learning (for example Google's Deep Mind computer system and also AlphaStar's), achieve equivalent effects in specific fields of contests and games, and are feasible to produce a level of symbolic capacity in systems and machines (respectively with TD and BU techniques, when playing chess, and / or playing Go respectively, with professional players and winning them), we will explain them here in more detail later regarding the symbolic display.

Terminological note: The use of the term "symbolic" can have several meanings, from a purely syntactic representational character, which is restricted (linguistically clearly significant, for example the word "apple", linguistically speaking, has a certain level of abstract value but physically tangible as an acoustic signal pronounced by a speaker or reflected in a writing, for example), up to a more globalizing representational character including the signifier + the meaning, “the image of a red apple”, which would be more illustrative of the meaning (see Figure 1 below the photo of an apple, even more clarifying of the part of that meaning); the specification becomes more concrete, the more visually perceptible (by context or by image). Here we may be interested in expressing one or another assessment of the symbol at different times, and we will try to specify it when the term "symbolic" appears. Also derived meanings, such as the term "subsymbolic", express something below the two previous meanings, for example, expression using strings of bytes, which can express, a word, a phrase, a paragraph, or in another version, an image any sensory encoded in a binary digital system from multimedia systems, pixels on the screens, alphanumeric keys on keyboards, etc. term to be used as well.

On the other hand, "presymbolic" will be the name for the situation of baby-children, before the verbal eruption, which we know have mental images and processing (such as vowel sounds first and consonants later, before forming words), but they do not differentiate the real image of an object from that of a realistic photo of it; This symbol can appear as a photo materialized on paper and with realistic 3D figuration.

1. The emerging verbal irruption in babies-children. Essays, analyzes and empirical data.

We will advance a definition of sign, extensible to the symbol and the signal[12] (with their differences), in the field and current paradigm of the theory of information processing, by P. Rocchi (2012), and the first fundamental definition in his study:

A sign has a physical origin (= E) and stands for something in the world (= NE). [1]

[10] Feyman, Richard (1965). The character of physical law. M.I.T. Press.

[11] Russell, S. J., Norvig, P. (2011). *Artificial Intelligence*. Pearson Prentice Hall
Torrens & Parra (2017). *La inteligencia artificial*. RBA
Belda, I. (2017). *Inteligencia artificial*. RBA
Pareschi, R., Dalla Palma, S. (2019). *Inteligencia artificia*l. Emse Edaps S.L.
Rodriguez, P. (2018). *Inteligencia artificial*. Ediciones Deusto
Rouhiainen, L. (2018). *Inteligencia artificial*. Editorial Planeta s. A.

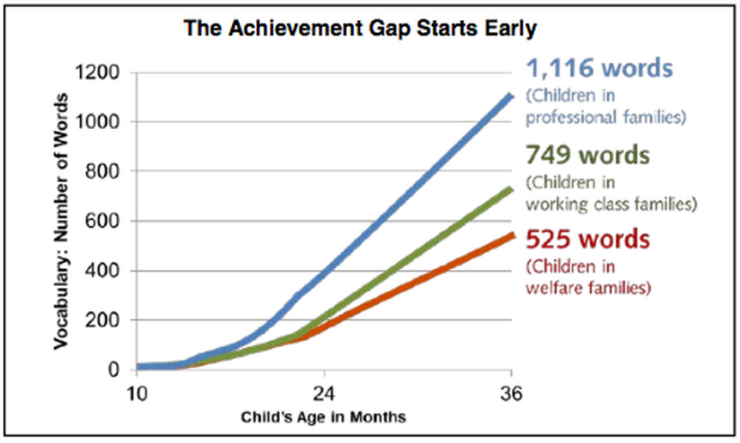
[12] Touretzky, D. & Pomerleau, D. (1994). *Reconstructing Physical Symbol Systems*. Cognitive Science.

“E” being an entity and “NE”, any other than E, and will find a meaning. In fact, it is an approximation to the object-event (OS) itself, an identity that does not occur even ideally ontologically (or is an object or is a symbolic representation, which are mutually exclusive), but which representationally is closer to NE than E starting used.

Symbolic capacity exists when an organism or machine is capable of performing that function by accessing the state of mind that it provides (H. Keller in his learning of <water>), and is more capable, symbolically speaking, the more number of symbolized entities it contains (with meaning), his mental world.
The detection of the distinction of the symbol in children with respect to the represented object (Judi DeLohache, 2005), is a threshold that is determined as it occurs in systems of objects visually represented with realistic photos (in 2D but with 3D perspective and in color).), facing children, and how the object-events (OS), with models of different scales (such as hiding dolls and locating them outside the model in an identical room) show symbolic limits. All this has been repeated in a culturally very different environment from that of a normal school in the United States; This has been done in contrast to an African ethnic group in a tribal setting in Africa. Children between 1 and 5 years of age responded similarly, without changing cultural effect, results that were common. 1-year-old children in both cultures seek to “catch” the object represented in the photo, and when they become 2 years old (see photo Figure 1 of a child wanting to take a bunny from a photo, in a video presentation DeLohache 2005), they prefer the object to the representation.

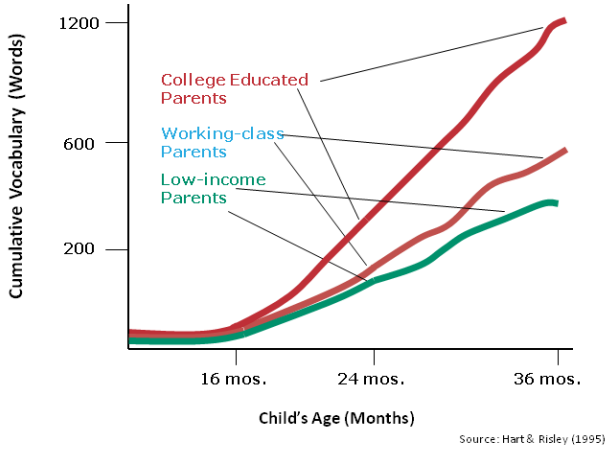
Figure 1

But that symbolic process within visual sensory stimuli occurs equivalently in verbal stimuli and their learning. Below we can see two graphs from the Hart & Risley study from 1995, differentiating how this emergency appears at 18 months, and how it progresses.
It can be seen how the foot of the vocabulary acquisition curve begins, like the most generic symbolic capacity, at 18 months.



Source: Hart & Risley Study 1995

Disparities in Early Vocabulary Growth



Depending, of course, on their level or speed of emergence, on the family level from the labor point of view, social class and family resources, detecting a quite different speed of irruption of language, although in all cases it is equally disruptive.

2. The emerging learning curve and its function

The Ebbinghaus (1879) precedents of memory studies with the forgetting curve, using words, allow us to deduce the memorized acquisition by learning, which as an inverse process, assumes that both, carried out with adults, proceed to develop memory learning, and with lists of words having faculties considered within the normal population curve.
The learning curve is a logarithmic curve and, although there are several formulas graphically, they respond graphically to the figure presented here at least in large part.

The reasons for the sudden growth pattern, as the introduction advanced, are explain by network theory of Erdös and Renyi; and the speed of change, for being a cumulative phenomenon, which like the configuration, is reflected as a curve of Gauss, which in cumulative form is the sigmoid, or a fraction of it.
Simplified, it is equivalent to the diagram on the left of Scheme 1, in which we see a ramp or step in which there is an increase in the information level of a system in a short time, and which we have called the Time diagram of the

complexity, as it temporarily illustrates an emergency process.
Let us see in our own language this psychological unfolding of potentiality, and produced in a segmented way, with several characteristics related to learning and memory, underhandedly:

(1) The mechanism of **iconic memory** [13](U. Neisser, 1967), at the beginning of perception (150-1000 ms of persistence).

(2) The neural mechanism of **engrams**[14] encoded in neural networks, underlying the resident knowledge in the brain structure of immediate, working and long-term memory. The codes captured by Joni Wallis (2006-2009-2010), with micro-electrode mini-panels suppose a direct taking of these engrams, in this case for decision making with electrode systems implanted in apes.
Similarly, and in a resident way, they mean the neuronal structures of mirror neurons, or those of the chained sequence of motor actions.

(3) Between the before and after of the iconic memory and the engrams, the unfolding of the sigmoid curve, with which we have a zero or very little symbolization speed at those ends, and in the center of the sigmoid, with a ratio that is maximum (in the verbal irruption between 30 and 60 learning words per month).
In the stasis of the sigmoid, a cumulus of the order of a thousand words has already been acquired, which will also appear with the new learning terms that are punctual, far from the commented emergency and presented as a step of words (see Diagram 1 of above), and new state of mind; and although it will never stop during the child's development, it will continue with much less rapid, but continuous, learning that takes place throughout life; both by learning in new disciplines during school, university and professional training, and for example, in new languages that can be learned later.
The learning curve, with the appearance of symbolic capacity, seen from RW, begins in the 18 months of development of the baby-child, and their verbal learning grows from a function such as the following:
Analytical extrapolation of the expression and sigmoid curve according to the theory of Rascorla and Wagner[15] (1972), being:

E1: event 1
E2: event 2
E1 => E2, relationship or association
λ: E2 processing when unforeseen
V: associative force of E1
β: salience of E2
α: E1 salience

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[13] Diersen, Mara (2018). *¿Cómo aprende (y recuerda) el cerebro?*. Emse Edapp S.L.

3.0 Essay: The iconic dimension. A new quantified information extended model. Web INGIT.ES - Projects

[14] Liu, Xu; Ramirez, Steve; Pang, Petti T.; Puryear, Corey B.; Govindarajan, Arvind; Deisseroth, Karl; Tonegawa, Susumu (2012). *«Optogenetic stimulation of a hippocampal engram activates fear memory recall»* (http://www.nature.com/doifinder/10.1038/nature11028). *Nature*

Mu-ming Poo, Michele Pignatelli, Tomás J. Ryan, Susumu Tonegawa, Tobias Bonhoeffer, Kelsey C. Martin, Andrii Rudenko, Li-Huei Tsai, Richard W. Tsien, Gord Fishell, Caitlin Mullins, J. Tiago Gonçalves, Matthew Shtrahman, Stephen T. Johnston, Fred H. Gage, Yang Dan, John Long, Gyӧrgy Buzsákiand Charles Stevens (2016). *What is memory? The present state of the engram*. BMC Biology

[15] Dickinson, A. (1980). *Contemporary Animal Learning Theory.* Cambridge University Press

dV: change in associative force of E1 in one trial

The RW equation is: **$dV = \alpha \beta (\lambda - V)$** [2]

If we call the number of the trial “n”, and if we admit that this variable, instead of being discrete, was continuous, with a differential gradient, with respect to the dV gradient, it implies the dn gradient, which in the form of an analytical equation, would result:

$dV / dn = \alpha \beta (\lambda - V)$ [3]

which is an integrable equation where, α, β, and $\lambda$are constants for a case V = f (n),

integrating: **$V = \lambda - (e^{-(n\alpha\beta - k)})$** [4]
where n = 0 and $\lambda = 1$, then k = 0; otherwise $k = \ln \lambda / \alpha \beta$ [5]

Equation [4] has the advantage of being a continuous function, whose variables are “n” (independent) and “V” (dependent on “n”), whose associative force for a given task as it is learned, increases first. and then saturating in a sigmoid, until its stasis, at which point the repetition of another "n" is no longer relevant in the growth of "V".

In this case "n", it is translatable through the concept of "duration" from "n" to "time", "t", to compare the formulation in terms, such as those of Scheme 1. And the form of the function of this mode can be V = f (t).

3. Emergence of the new symbolic mental state. Its feasible rise, stasis, decline and loss.

The linguistic meaning is registered in the cerebral cortex not locally, but rather distributed[16] throughout it. The analysis of Huth & Gallant Lab (2015) by fMRI, published in Nature, illustrates this state principle empirically and that we see in the following Figure 2.
The possible phrenological allusion, and that an observant and reasonably skeptical neuropsychologist can make, is only anecdotal, or a conjecture. The instrumentation that shows the causality, reproducibility and correlation of the cerebral structure of the cortex, with the linguistic meanings, clarifies that it is not possible to object to the existence of arbitrarily significant zones (like the one phrenology did in its day), but rather to a proven and feasible way to reproduce (at least in English, warned by its authors).

[16] Maestu, F., Perede, E., del Pozo, F. (2015). *Conectividad funcional y anatómica en el cerebro humano*. Elsevier. Pag.131

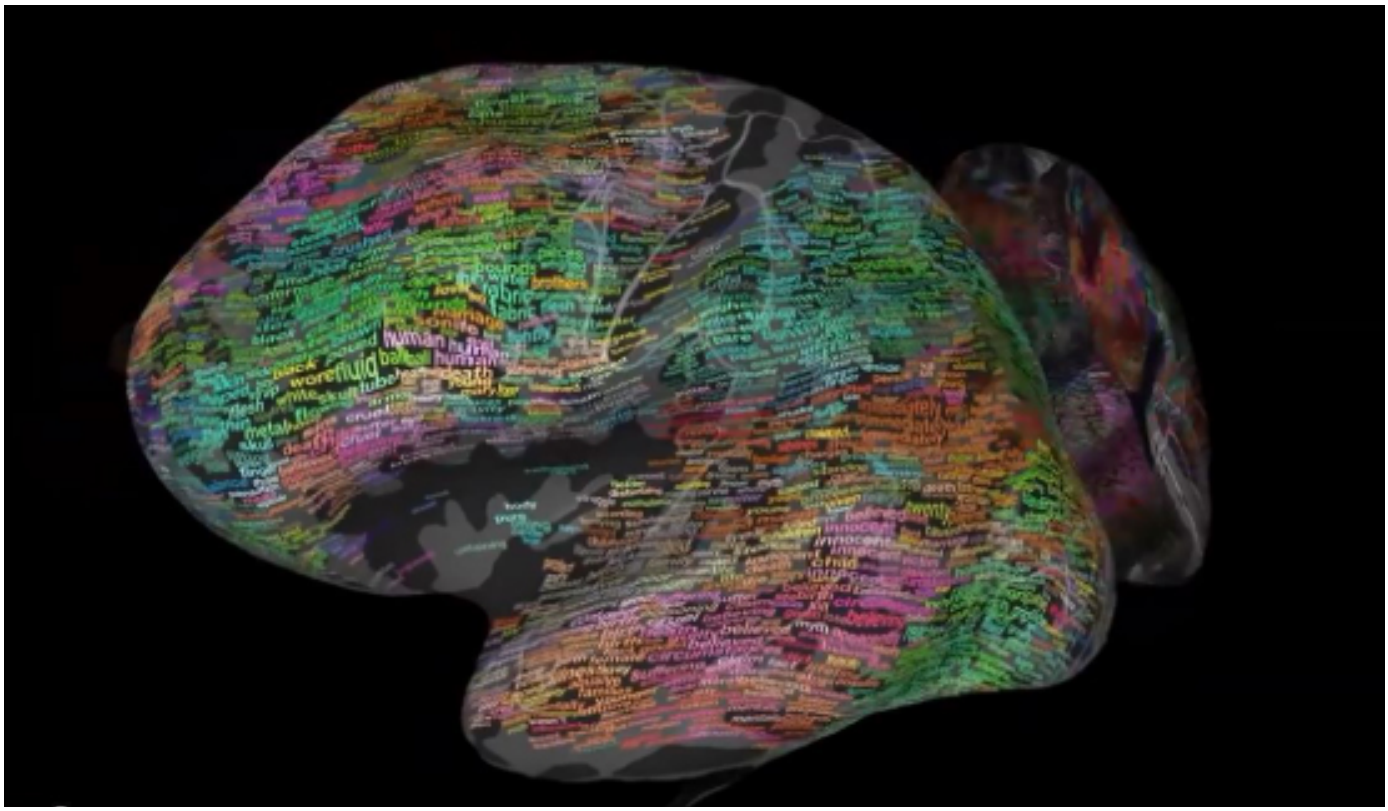

Figure 2

On the other hand, a Gomez-Pin essay referring to the philosophy of knowledge may be illustrative, with the surprising proposal and observation during the essay, on the knowledge of slaves in ancient Greece[17], which establishes that the functionality of speech is indicator of already having a fundamental and seminal knowledge; it supposes the potential knowledge of the general human knowledge given implicitly in that knowledge. The syntax of speech is demonstrative and capable of structuring logic, and through it there is access to algebraic knowledge, he says, and from this to geometry (the equivalence between logic, algebra and geometry is in the field of well-recognized mathematics); if this happens for anyone with the speech function, the verbal symbolic capacity is present. That is why, although we speak of a poorly cultivated slave, as much of the population was in ancient Greece, the fact of speaking already made them potentially knowledgeable, and with the demonstrative ability of the human symbolic capacity towards any knowledge. All this is consistent with the foundation of Chomsky's Law of Universal or Generative Grammar.

Continuing with the language, A. Gomila (2012)[18], expert in topics of <meaning>, describes the capabilities it is symbolic verbs of the mind as the most important property of the mind itself, to the point of identifying the mind with its verbal capacity; naturally with <all> its associated symbolic capacity, from the use of signifiers, or physical agents of language, as well as the extremely important meanings or possible meanings of the verbally or written articulated word, being possible the analysis, syntactic, semantic and pragmatic.

But this mental state is underlying in all languages, until the baby-child does not begin to "act" at approximately 18 months of age. It is an arrangement, a "potential" of the species. This latent potential in every child, which appears in all the ethnic groups of the world, has the same intrinsic rules. N. Chomsky

[17] Gomez-Pin, Victor (1989). *La filosofía. El saber del esclavo*. Editorial Anagrama, XVII Premio Ensayo
[18] Gomila, Antoni (2012). *The verbal minds.* Editorial Elsevier

(1968)[19] analyzing and contrasting languages, identifies more than twenty structures or common syntactic rules, and which as a whole calls them Universal or Generative Grammar Law.

The existence of this system of rules in potential and latent form, suggests several proposals: 1) the base is an infrastructure associated with the heritage of the species, which is genetic, 2) has the epigenetic potential associated with a time window in which the external cultural stimuli make it manifest ("wild children", because they do not have this activation in the corresponding time window of child development, do not activate that capacity), 3) which suggests how the corresponding biological evolution could occur, in which the Language acquisition supposed an emerging symbolic capacity in generations in which the Baldwin effect (J. Sampedro, 2002)[20] was probably essential, and the progressive use of symbolic qualities (Burling, 2005)[21] with, first <indices>, then <icons >, and finally the gestural and verbal <symbols>, was performed first; summarily, they ended up being used with all modalities and together in the versatility of language. Thus learning became instinct (J.M. Baldwin) in biological evolution, but instinct also develops in the child displaying, among other qualities, a main capacity, which we have here called the symbolic capacity of language.

Gardner[22] and Goodman[23] define the symbol as well, and Gardner refers to it this way: <I take a universal point of view of symbols. Following my mentor Nelson Goodman and other authorities, I conceive as a symbol any entity (material or abstract) that can denote or refer to another entity> (terms accepted in updated information theory, P. Rocchi (2012), and seen in the formulation in [1]), and also explain how symbolic capacity bridges the gap between cognition and culture, from the internal psychological and the external aspects of the execution of art in physical works; This expression of symbolic capacity, as a specific cultural field, and that we can extend to culture as a whole (with the sciences, arts and humanities), making Gardner explicitly add: <The domain of symbols, consisting of scholars, it is ideally suited to help bridge the gap between the entities mentioned, the nervous system with its structures and functions, and culture with its roles and activities> (bold and underlined by us).

S. Pinker establishes in The Language Instinct (1994)[24] and *La tabla rasa*, how language, an underlying factor in development, manifests itself as a biological instinct; and just as the mind is not a blank slate on which the contents of what we are mnemonically speaking are written; otherwise it is done by biology, which already brings with it a large part of that symbolic capacity prepared to unfold. Pinker disciplinarily considers four bridges between biology and culture, and that this deployment has been developed with four disciplinary and scientific fields of study (understanding culture as the collective result of learning the mind with multiple symbolic capacities): 1) Science cognitive, 2) neuroscience, 3) behavioral genetics, and 4) evolutionary psychology (the latter is analyzed by Pinker from the point of view of reverse engineering, and which we formulate understood as follows: “if something has evolved, and its steps are known, with a technology with sufficient development, it is feasible to be artificially reproduced ”).

It also provides an analysis of the concept of mental language, <el mentalese>, a term devised by Fodor, (J. Fodor, 1983), which suggests in our framework that, before the child manifests the verbal symbolic capacity, he has a presymbolic[25] capacity nonverbal (among other facets of this internal language called “mentalese”), with it performs cognitive actions that have been studied systematically in babies, even as a baby, such as Alison Gopnik[26] (2012). At a minimum, and without even the verbal symbolic capacity, it

[19] Chosmsky, Noam (1968-1972). *Language and mind.* Harcourt Brace Javanovich Inc.
[20] Sampedro, Javier (2002). *Deconstruyendo a Darwin.* Editorial Crítica
[21] Burling, Robbins (2005). *The Talking Ape*. Oxford University Press
[22] Gadner, Howard (1993). *Estructuras de la mente*. Ed. Fondo de Cultura Económica
[23] Goodman, Nelson (1976). *Los lenguajes del arte. Aproximación a la teoría de los símbolos*. Ed. Paidos
[24] Pinker, Steven (2002) . *La tabla rasa* . Editorial Paidos 2012
[25] Kuhl, P. K. (2016). *Como adquieren los bebés el lenguaje*. Investigación y Ciencia – Enero 2016
[26] Gopnik, A.;John Brockman, recopilación(2012). *Mente*. Editorial Crítica

analyzes how the baby thinks in all probability, and as an important part, he does it with the sensitive impressions he has had throughout his growth within the mother and throughout her short life outside of it.

Patricia Kuhl (2016), establishes as first actions that we call presymbolic occur, such as: early learning of vowels (at 6 months), then consonants (at 9 months), making word recognition and finally the beginning of the articulation of complete words at 18 months (Harth & Risley, 1995).

To qualify, we have to describe this symbolic capacity as that of the use of the most global symbol advanced above (successively **indicative, iconic** and **symbolic**[27], the latter being propositional, we qualify here). The capacity that the symbolic character as a whole achieves, not only with semantics, but also with syntactics and with pragmatics, with which the function of semiosis is established (as a unified act of metalinguistic knowledge of a semiotic character: **syntactic, semantic** and **pragmatic**[28]; with the relations that describe them respectively, those of the sign-sign, the sign-object, and the sign-subject or sign-observer more generally, and since Ch. W. Morris (1938-1971), making the sign in all forms and deficiencies This is multifaceted manifested in the "wild" and natural praxis of use (to put it in some way as we communicate, in the everyday, normal and synthetic, even confusingly); also customs, or spontaneously I live, displaying the language that is commonly used, not subject to distinctions, semiotic models, or linguistic norms. It is heterogeneous, a mixture and fusion of communication. ion, even with the presence of the subjects, including the semblance of the face and gestures, plaguing the communication of hybrid signals, but converging in the meanings that are shuffled.

The Semiosis that is the main linguistic, psychological and philosophical act of the use of language, managing the virtuality (polysemy, synonym, antonymy, etc.) of it for a communicative utility, as well as social and biological survival (basic to have meaning networks quickly gives contextualization with few access steps), makes it easy to use the meaningful environment of group relationships; This is also handled, in an anthropologically understandable way (in the "emic" version -as a native within a group- and in the "etic" version - as a foreigner, as an agent or subject-observer external to the cultural group-, versions of information normally very different).

Thus the mind, and the symbolic capacity activated as a new brain state, manifests itself as a phase change in an emerging physical process - like the passage from solid ice to liquid water, or liquid water to the vapor state -; and it is established in new stasis, that is, a stable state after a process of change, and it happens while biology is active in the normal human functioning of the development of a baby-child, and visible in the language expressed in the social group.

As we said at the beginning of this paragraph, the registration through fMRI of meanings in the cerebral cortex[29], illustrated in Figure 2, is an objective verification of how meaning from the symbolic (appears globally, and reaches the semantics physically with their brain networks), allowing to observe and understand the significant contents, using interconnected neural networks of knowledge.

But there is more, learning new meanings activates the reward circuitry and produces a pleasant chain from the subcortical areas of the brain every time we learn a new verbal or written meaning[30]. Learning thus creates a relationship in which the most far-reaching linguistic functionality, the new meaning (which expands the internal symbolic world) is biologically integrated into the individual. This link, similar to when

[27] Burling, Robbins (2005). *The Talking Ape*. Oxford University Press
[28] Bosch, Colomé, Diego-Balager y Rodriguez-Fronells (2014). *Neurociencia cognitiva (Cap.19: Lenguage)*. Editorial Médica Panamericana, S.A.
[29] Huth & Gallant Lab. (2015).
[30] Ripolles et al. (2014)

H. Keller, the deaf and blind person integrates the meaning of the word “water” (see note 6, testimonial of the case), and is rooted biologically through circulating dopamine in the reward circuit, thus establishing a link between the signifier and the meaning of the new learned sign or term, in this case, the gestural symbol on his hand of a deaf-blind person, associating it with the sensitive evidence of the object-event <water>.

The divorce that occurs in the arbitrary link between the signifier and the signified, so clearly manifested since F. Saussure, is even more so today, expressed by Harnad (1990)[31] in the concept of Symbol Grounding Problem (SGP), describing what typifies this separation. This separation that is overcome with activation of the symbolic capacity with all its mechanisms (genetic, epigenetic, emergent brain, of the reward circuit, contextual in the linguistic network, with Baldwin effect during evolution, Chomsky's Universal or Generative Grammar, and among others, such as the bridges of biology-culture, to which S. Pinker refers above).

Decline and loss of symbolic ability

Illness and accidents are producers of manifest deficiencies.
Alzehimer's disease, senility due to natural aging, traffic and work accidents (for example without the necessary protective helmet in the construction industry), episodic incidents of blows and falls, deep crises of psychosis and strokes -strokes, are responsible for the loss of symbolic capacity-.
The physical brain correspondence, with the impaired functional effect is always close, more than that, corresponding, both if the causes are exogenous (accidents, from the environment) as if they are endogenous (cholesterol, immune system, endocrine, neurological, or psychological) or combined[32] (as it produces stress and fatigue).

Causality analysis to avoid, or stop cognitive loss, can be essential; Measures for prevention and prudence in behavior must be applied throughout life in long-term care and health. From nutrition, to physical exercise, from healthy breathing, to rest and sleep, or to activity without stress and the vital project for each one psychologically satisfactory. And that will not guarantee good mental health, because by direct or combined genetic and epigenetic dispositions, the decline can still be triggered (the safest and most inevitable is aging itself).

For all these reasons, it is difficult to establish the “zone of proximal deterioration” that can occur at any time. This term is recreated from the analogy of the "zone of proximal development" for learning, which Vygotsky says is key to advancing education and knowledge. But the same is proposed here and vice versa, for deterioration. For this reason, it is worth questioning each or every case, as well as with experts and medicine in the sector; basically to prevent physical health as a first step in therapeutic or / and support psychology, highlighting the loss of symbolic capacity, especially the verbal semantics.

It may be time to frame symbolic ability with cognition, intelligence, consciousness, information processing, memory, and behavior (as articulation of linguistic expression), as high-level functions and states of mind. This is not established in a way recognized and generalized by all the scientific specialties and specifically the neuropsychological ones, but there are some clues, we expose them and detail appealing to aspects of symbolic capacity:

[31] Harnad, Steven (1990). *The Symbol Grounding Problem*. Physica
[32] Tafet & Neverot (2016)

1**) Cognition** is psychologically, the ability to know the environment, being carried out from an organism, and that through perception and its centralized processing (probably similar to neural ganglia in simple animals such as insects), occurring in a larger nucleus, the brain, as most complex animals do.
On the other hand, cognition has become a pragmatic term of information processing capacity, therefore very close to symbolic processing capacity, or symbolic capacity itself. To cover it broadly, it is important difference to distinguish significant and significant processing. The first in extensive use in all telecommunications, the second not explicitly, is usually broadcast in basically visual and acoustic analogue perceptual images, based on a given object-event (OS), or set of OS's, even if they are transmitted on telecommunication by digital means. In summary, it is thus important "digitally" speaking, the gain in precision, accuracy, and reliability in general, but it is presented as: a text (more digital than analog), or / and as are the registers of images and sounds (more analog than digital), which are the ones that really communicate in their presentation to the observers, and on a given matter <OS>, through the patent and evidence of that object-event of origin.
Partial cognition, but quite central as a criterion, is also parallel to the computational capacity rate of computer machines[33], which are encrypted in processing capacity in bytes per unit of time. The FLOPS (Flotating Point Operations per Second), rate the microprocessors with this value, giving the data processing speed: kilo-FLOPS (kFLOPS, 103 FLOPS), mega-FLOPS (MFLOPS, 106 FLOPS), giga-FLOPS (GFLOPS, 109 FLOPS), tera-FLOPS (TFLOPS, 1012 FLOPS), peta-FLOPS: 1015 FLOPS (approx. 5 PFLOPS are needed to simulate a Neural Network with action potential triggers, still pending if reached; and 10 PFLOPS is calculated to achieve Neural simulations; both according to note 33 below), exa-FLOPS (EFLOPS, 1018 FLOPS), zeta-FLOPS (ZFLOPS, 1021 FLOPS), yota-FLOPS (YFLOPS, 1024 FLOPS).

2) **Intelligence** is much more conflictive in its assessment than cognition, which is more generic, both due to multiple recognized and very important intelligences, up to general intelligence, as well as the format of the tests themselves. And it is clear that it not only supposes processing capacity, which also, but encompasses the understanding, both of the object-event (OS) of origin, and of the interlocuting subjects who perceive the semiotic relationship, for example, in the case of verbal intelligence (which is around 74% correlated, according to some experts with general intelligence or the G factor), is the result that converges very well with the analysis of <verbal irruption> that we analyze here, whose precursor factor is symbolic capacity , as we are exposing.
Its extension to Artificial Intelligence (AI) is not trivial, and we will develop some aspects in paragraphs below; The latter is basically a remarkably reduced version of biological intelligence, at least for the moment.

3) **Consciousness**, always elusive as a concept and as analysis, continues to advance in it, and appears quite clearly as the basis of <consciousness>, for example in an approach by M. Bunge (1983)[34], considers that this is "(…) The sum of all conscious states ”(we have a concrete idea of some interest for the simple and refutable of <consciousness>, and its signified “cum scientia ”, with knowledge). However, this is not generalized in its acceptance, and the aspects of the study of consciousness go further; from Tononi's Integrated Information Theory, to those who, at a medical level, establish and generally accept how anesthesia nullifies consciousness (not referring to the subconsciousness of dreams, for example, if they are held during anesthesia); and those who study it as existing at different levels by EEG, and agree to differentiate from the maximum activity of 40 to 100 Hz, gamma waves, with a proven activity in high mental concentration (for example for the study), to the minimum around 1 Hz in deep sleep, called delta waves, that appear without REM waves (Random Eyes Movements, of dreams with images, coming from the ocular saccades during observation while awake), which manifest around 5 Hz.

[33] Kurzweil, Bonstrom, Sandberg (2005-2008-2018). *Artificial brain (Graphic).* Wikipedia Commons.
[34] Bunge, M. (1983). *El problema mente-cerebro*. Ed. Tecknos

REM waves are usually clearly indicative of the existence of dreams. On the other hand, the EEG electroencephalographic parameterization is with which it is judged that there is brain death in the absence of activity (flat electroencephalographic recording, 0 Hz), and it is generally accepted, and technically, as biological death.
On the other hand, and at the other extreme, the finding of the existence of two consciousnesses in the brain, when the corpus callosum is therapeutically excised (avoidance of some epileptic phenomena, with lobotomy by surgery), is very surprising and highly indicative (Gazzaniga and Sperry) of the functioning as a whole of the brain set, until the moment when in the same brain it remains with the two hemispheres separated and therefore with two different perceptions, which manifests two different consciences. Binocular rivalry is another exponent of hemispheric differences that solve internal connections, but that are differentiable.

Therefore, the symbolic capacity, precursor of general intelligence, is also present in consciousness, as an important component, especially with significant information, which we will see in more detail in the next section with the information process.

4) Brain **information processing** is considerably uneven, especially in the two separate hemispheres discussed above. Sperry (well illustrated in his speech as Nobel Prize in medicine) and Gazzaniga[35] (text about the divided brain) express it punctually. Both consider as very relevant fact that usually the right hemisphere processes information synthetically (prosodic and musical area), spatially and truthfully, just as the left hemisphere processes it analytically (linguistic area), sequentially and hypothetically (in the latter term, everything is subject to the existence of a fit, especially with the preconceived, which may be wrong, but conjectural, and that also the left hemisphere does not care that it is so and does not question it).

The case of Jill Bolte Taylor (2008)[36], with a stroke in the left hemisphere disabling it, is particularly interesting, as she is a neurologist herself and relates how her experience has been with a vision not only of the patient, but also that professional role neurology specialist (talk at TED 2008, and related text). In the same sense, the polarity of the hemispheres is illustrated quite well by Sergent's Spatial Filter Theory (1983), also in Ivry & Robertson (1998), being the low-pass filter the right hemisphere and the high-pass filter the left hemisphere; the metaphor of the “forest” is valid here, which is equivalent to seeing the “set of trees or the forest” (what the right hemisphere does HD), or seeing “a single tree or one by one” (what the left hemisphere HI)[37]; Natural selection has facilitated survival in the hemispherically bicephalous animals, using both the set warning ("realize") (HD) and the detail (HI). This polarity works transcending a single typology or modality of perception (either visual, or acoustic, or tactile, or olfactory, or gustatory, basically), we would speak of processing of the first case with a tendency to <analog> and in the second to < digital>; this, in current technological terms, and as computer systems are developing, with the current emphasis on the “digital paradigm”, scarce until a few decades ago, but currently of considerable application as a telecommunications revolution, and which can serve to visualize the passage from natural organisms to artificial systems.

Jill Bolte Taylor's casuistry is relevant, for living it as a subjective state with the objective training of a neurologist. The factual state of the two consciousnesses illustrates how the processing of information by the two hemispheres is polar and physically integrated through the corpus callosum, and psychologically the integration of information by a processing such as that indicated by Tononi[38] or similar and / or

[35] Gazzaniga, M. S. (2018). *El instinto de la conciencia. Como el cerebro crea la mente*. Ed. Paidos.

[36] Bolte Taylor, Jill (2006). *My Stroke of Insight: A Brain Scientist’s Personal Journey*.

[37] Banich & Compton (2011). *Cognitive Neuroscience(Chapter Hemisferic Specialization)*. Wadsworh Cengage Learning.

[38] Tononi, G. (2004). *An information integration theory of consciousness.* BMC Neuroscience

supplemented by Edelman & Tononi (2000)[39], and which manifests itself as essential for the single consciousness, when the hemispheres are not separated by the sectioning of the corpus callosum or some disease that produces its incapacitation.

5) **Memory** is the set of images, objects and facts that are stored and can be remembered psychologically. They are like the storage of "big data" in computers, but this capacity is not trivial at all (it is not a formless mass of accumulated bytes; they are rather "little" pieces of information). Big data in machines, also called data mining in the acquisition of them, this showing off your ability to solve problems using huge data sets on a system; in contrast to what was formerly done with carefully designed statistical sampling. Precision can be sacrificed, as more data is available from the system being studied; in turn, it is more representative for being a large population of indicators. This is only possible with a system for processing such information, in the case of machines with latest-generation artificial intelligence (AI), using machine learning. But in addition, we must bear in mind that qualitatively, perception and **memory is iconic in origin[40]**, (persistent 150 - 1000 ms) and is a gateway with a large analog, as well as digital, load of symbolic code, such as signs or texts, at least in the case of organisms in general, and in animals in particular, including humans. The iconic factor (in a generic sense, but in particular the call in perception <iconic memory>, persisting those 150 - 1000 ms, includes all sensory systems, not only the visual one), is the first filter towards human memory, which by evolutionary reasons processes with an analog and a digital trend, as we discussed in the previous paragraph and we will return to the visions of the TD and BU functions.

6) **Behavior**, treated not only as movement, but also as a linguistic articulation of signals, such as those of speech or gestures (including the language of the deaf and dumb), is decisive for the relationship with the environment. Robots, which were initially and exclusively robotic arms for the industry; they are also previously piloted machine tools, such as shovels for loading and moving earth in construction; or the large-scale hammer drills, which started this journey from the automotive assembly lines, towards a complex and slowly anthropomorphic robotics that includes it simply according to the utility and functionality of the industry. But also with complex non-anthropomorphic versions, such as smart talking speakers, interacting with the user through voice (Google, Amazon, Apple, Telefónica).

Anthropomorphism in robotics is not trivial, not even seen as a mere extension of our morphism, because they may be due to performance reasons. Like the functions that we have to perform in our floors and houses, in which everything is adapted to our shape, and a simple movement of plates and glasses from a dishwasher requires anthropomorphic form to perform the function of loading-unloading the machine. The paradigm of embodied intelligence (Lackoff et al.) Also shows how the biological constitution as animals does not end in the action of the mind with the brain, the body is fundamental as the nurse of the brain, and in this way the environment interacts with the body. These interacting factors are synthesized for the most part, in a very long word, alluding to the systems that compose it: psychoneuroimmunoendocrinological systems (Tafet & Neverot, 2016), to which is added the classic perception-action cycle of the organism with the environment, for example seen from J. Fuster (2003). This criterion may polarize machines in the future, not point by point, but to encompass the entire series of internal behavioral and operational functions efficiently and as a traveling ecosystem, reverse engineering from what we are functionally speaking.

Commentary

It is not surprising, that the entire advanced trajectory of basic physics, its derived sciences such as cosmology, and others such as biology with evolution, have been largely referents, to de-anthropomorphize man as the center of the environment and the universe (Galileo, Einstein, Darwin,

[39] Edelman, G., Tononi (2000). *A universe of consciousness- How matter becomes imagination.* Published by Basic Books.
[40] Diersen, Mara (2018. *¿Cómo aprende (y recuerda) el cerebro?*. Emse Edapp S.L.

among others). In the preceding paragraphs, there may be another significant key, applied simply to the contrary, in an anthropocentrism as a strategy for knowing ourselves, within the context in which the topics are developed, and without renouncing the essential objectification of the scientific approach.

3. Symbolic and subsymbolic artificial intelligence (AI)

To illustrate AI as largely symbolic-capable processing, we drew on milestones achieved in machine information processing, as with the game of chess and Go, which we advanced in the Introduction; they have been carried out with emulation of players in games and experiences, which have allowed the detection of stages of achievement with current computer technology.
Human symbolic capacities, from the end of the last century to the present day, have been identified in an explicit way with the analogical and also with the digital, we are going to analyze two references regarding these terms, differentiating the starting point (analog or digital) and the arrival target (identically, which can be analog or digital),

It is necessary to keep in mind that learning is the fixing of symbolic capacity relative to specific topics, so when we talk about learning in machines we are talking about fixing a symbolic capacity normally through sensors, which are always analog and have transformed their signal for transmission (more precise and exact than analog) with a digital fixation, in this case in electronic memories of all kinds, and which in their availability constitute the memory of what has been learned.

- For **initial** analog symbolic techniques, we consider those developed with expert computer systems, for example in linguistics, which denote “digital or analog signifiers” **as targets**, and which are called “top-down” (TD) or productions with **methodologies of fractionation-analytical-digital** final. Its simplified equivalence would be equivalent to processing with words a description by name, or a phrase (as a linguistic-written component), and describing the object, made up of the letters of the alphabet (from alphabetic symbolic fractions of those letters, and even up to the binary code if required), for example the sentence,

=> **<Red apple Royal Gala medium size>**

(In detail, as a component of a smaller coded origin; also with more specificity, we could describe from its components, first a context, in a text, then the **phrase**, then **words**, and finally the **letters**:

< [R e d] [a p p l e] [R o y a l] [G a l a] [m e d iu m] [s i z e] >)

- On the other hand, the **initia**l digital subsymbolic techniques aim to achieve a holistic “meaning”, such as the image, they are considered, among others, the basis for deep learning in machines that achieve this as **an objective of arrival**, being technical called “botton-up” (BU) type or productions with **holistic-synthetic-analog** final methodologies. Its simplified equivalence would be equivalent to composing with pixels a realistic photo of the object,

Note that we have used two versions of the dual code of representations (A. Paivio), the verbal representations for TD, and the image representation for BU, of the same object, <block>. It has been done to the extreme, to push the analog as a joint vision and the digital as parts. In fact, either could be used to exemplify TD and BU.

TD and BU functionalities

From the symbolic and associative capacity from the AI, it was the proposal with which Minsky, Newel and Simon (1956)[41], solved with conventional and complex computer programming; To do this, they used the **"top-down" (TD)** function of intelligence, and it was developed within AI in a first stage. The TD functional approach was fundamental for being the first, although not the only one; and it was in the agglutinating-functional sense of a classic computer program, although to illustrate it we can take a simple format (such as processing through significant words, with the phrase that describes the "apple") or complex (as a program that displays the game of chess, and that was able to beat Kasparoff); We consider this functionality the most relevant of those that will be discussed here (as emulation of the symbolic human TD capacity); its foundation lies in Bayesian statistical methods of information, and not connectionist methods.

From that first assumption, TD is not the only artificial intelligence programming strategy, as has been pointed out; so it was, at the same time, and in the same conference of the year 1956, F. Rosenblatt (1928-1971), presented what later together with Mc Culloch & Pitts, they considered a fundamental concept for AI, although opposed to the previous paragraph , the **"botton-up" (BU)** functionality or connectionist method, is a method based on computation with networks of artificial neurons. It can be simple (the photo illustrating an apple, based on a programmed pixel structure, which simply makes pixel by pixel emerge an image on a screen) or a complex program (such as an inf program self-learning game that deploys the game of "Go", from a rudimentary beginning, to beyond the best known player), and its format is connectionist.

If we take the assertive metaphor that <*the trees should let the forest be seen*>, and <*the forest is a set ecosystem of individual trees observable one by one*>, the TD and the BU can be complementary (as a construct or relational articulation, seen in the right diagram of Scheme 1 above). We think it is a key concept to be replicated with functionalities in technology, emulating human intelligence in this regard; being able to be developed from the base of artificial intelligence (for example: see in the same Scheme 1 above, being P, the "trees", the parts, and being T, the "forest", a whole, forming both as an interactive unit of the operational set), the latter through a function performed by neural networks (on the one hand biological in the case of organisms, with "engrams"[42], and on the other hand, the networks of artificial-computer neurons, in the case machines), configuring an artificial intelligence AI with faster access and greater symbolic capacity (translatable into learning and memory performed and recoverable when needed).

[41] Darmuth Conference:
M. Minkski (1927-2016), one of the founders of AI, developed his activity mainly at MIT
H. Simon (1916-2001), Nobel Prize in economics
A. Newel (1927-1992), computer scientist and psychologist

[42] Liu, Xu; Ramirez, Steve; Pang, Petti T.; Puryear, Corey B.; Govindarajan, Arvind; Deisseroth, Karl; Tonegawa, Susumu. *«Optogenetic stimulation of a hippocampal engram activates fear memory recall»* (http://www.nature.com/d oifinder/10.1038/nature11028). *Nature*

It must be considered that both functions are probably complementary to **the emergency process** that provides human symbolic capacity using high and low pass filters[43] (Sergent, 1983), as we know it. We will argue its representation in each case:

- *The first*, TD, is the one that shows from the "**what**", and it starts from the high-level symbolic quality, but in the sense of seeking particular detail; as an objective, his analytical vision, or Cartesian division, is the vision of the "tree" within the "forest", after reticulating it fractionally; part of the reductionist method in the scientific study, and of the analytical methodology, which is the most general and the most recognized at present (the result next to it, and from the representations, is the verbal description of the "apple").

- *The second*, BU, describes with the "**how**" the typology with which such access to the high-level representational symbol occurs (by the process achieved by artificial neural networks from computer technology, as well as it would be possible from emulation, an extension of the analysis prior to biology, which is outside this article and its objective). In conclusion it is the capture or construction of a general form, the vision of the whole of "the forest", inductive, the perception of a general form or <gelstat> (in the example, the photo with the image of the apple).

The <**what**> and the <**how**> are necessary, when you want in a systemic process to have the feasibility of reproducing it completely. In the development of a baby-child, the process of having the symbolic capacity of language is cognitively speaking a function that emerges during the development of that baby-child, manifestly and measurably in its final effect, the <que> , established through the indicator of the number enrichment of language terms, and produces the linguistic phenomenon that has been called <verbal irruption>. The latter requires the <how> to do it and is a condition of the temporal window of early childhood interacting with human language; in wild children, in whom such an irruption does not occur, they are left without this access for life, and they present severe cognitive restrictions, which gives us an idea of the criticality of <how> and its importance.

In an artificial system, with which one would like to emulate the above, it would collect terms that it hears in the environment, and could reproduce them as "signifiers" initially (without explicit meaning), as they do under programming (and by corresponding learning, to which associate the meaning); For example, this could occur in assistant smart speakers, such as Google Home, Amazon's Alexa, Movistar's Aura, Apple's HomePod.

All of them, in use, are capable of giving intelligent responses while connected to the Internet, with different satisfaction for the user (without indicating who they correspond to, with market scores from many users, we report three of the above). They appear thus with a consultation consulted on the internet and at random, of: 4/5, another with 4.3 / 5 and another with 4.5 / 5. The nature of the responses gives us an idea of the capacity they have, basically with respect to the expectations created (which are very limited, nothing to do with the symbolic capacity of a child), restricted in the recognition and understanding of natural language, among other factors of these devices.

In general terms, they refer us to the operational applications for which they are prepared (playing music of choice, operating the TV, operating the radio, connecting with someone by telephone, specific reading of books aloud, home automation) blinds-lights-others). They also provide access to recognized Internet sources, such as Wikipedia, to answer general questions, access to YouTube; and it is easy to see that in our computers, the voice will soon allow an important interaction without the keyboard, through voice recognition that allows access to its contents and activities, such as in the use of video games. The improvement of these systems under the simultaneous methodology TD and BU, may be crucial for their

[43] Banich & Compton (2011). *Cognitive Neuroscience(Chapter Hemisferic Specialization)*. Wadsworh Cengage Learning.

improvement, whose symbolic capacity is now elementary, and basically of voice recognition formulated (the contexts and assumptions, escape these smart assistants, who are in incipient state).

The origin of TD and BU from the **event-object (OS)**, a real non-representational base component, which we describe indicating it as, for a given area, << a Royal Gala type red apple, with corresponding odor and flavor, and for be taken as dessert in a meal >>, for example; it is also the **origin** of representational "what" and "how", and this is essential. The gradualness of possible representation is manifest for each given object-event, from the minimalist allusion to art objects, to the representation with virtual and / or augmented reality for a given application of technology or therapies against phobias in psychology; or even the richness of natural language, which children can instinctively access with less difficulty.

That the systems are fed back, as it happens for example with the smart speakers, with the characteristics of the OS it is fundamental so that the programming TD and the BU, with the sufficiently dimensioned hardware (for example with GPU hardware, providing resources for powerful artificial neural networks , in this case), have a gradually or / and emergently optimizable guide (once TD and BU functionality has been obtained and implemented, with training). Thus, in the case of smart speakers, the need for the user to interact as long as possible with the system appears, since in addition to better voice recognition, there will be Bayesian predictive capacity (TD) like that of infant babies (Gobnik , 2017), and association of terms, which will provide machine learning capacity (BU) that adjusts to the user. On the one hand, it is continually refreshing with new inputs (vocabulary of well-recognized signifiers), and on the other, integrating them (in memory with user format based on meaning better understood contextually, with an action or a correct content of response).

Recapitulation

The first analyst of symbolic capacity, who was Ernst Cassirer (1923), was followed by AW Whitehead (1927), WM Urban (1939) and the synthesis of SK Langer (1941), integrating criteria of philosophers, logicians, semiotics, linguists, psychoanalysts, ethnologists and art theorists (such as Nelson Goodman20, 1976 or Ernest Gombrich[44]), reaching the present day with the processing of information and its revision according to P. Rocchi (2012).

Today, the vision of J. DeLohache (2005) and A. Gobnik[45] (2017) is notable, from the education and development of children, the latter even extending their analysis of the symbolic capacity of children, to artificial intelligence (IA), and that from this study we also share with the TD and BU strategies in the exposed terms.
Finally, reference that it is the symbolic capacity that supports and establishes the <what> and <how> of learning and associated cognition, with the following characteristics: 1) Function that unfolds in its approach in the development of the baby-child, 2) It is a bridging function between biology and mental states, 3) It is an emerging function whose essence is a new stable internal mental state, whose stasis enables and gives the human social subject greater understanding of the world, 4) This level of stasis symbolic and internal abstraction of the world obeys a probably scalable function, which is always the new knowledge, it can increasingly do, and this function can be deployed by education and continuing training.

[44] Gombrich, Ernst H. (…). *Arte e ilusión. Estudio sobre la psicología de la representación pictórica*

[45] Gobnik, Alison (2017). *Hacia una inteligencia artificial más humana*. Investigación y Ciencia – Septiembre 2017
Gopnik, A.;John Brockman, recopilación(2012). *Mente; Bebés increíbles*. Editorial Crítica
Gopnik, A. (2010). *Así piensan los bebés*. Investigación y Ciencia - Septiembre 2010

CONCLUSIONS

Regarding the objective addressed in this article

It has been to define the configuration of the emergency process of the new verbal symbolic capacity during the child's development, considering it as a human intellectual faculty; in this case the <symbolic capacity> that is located in the set of cognition operations. In another order, and finally, focus on how to emulate the process on computer machines capable of improving AI.

Regarding how this analysis has been developed

Through methods of analysis[46] of the complexity of networks, the emerging learning curve and the phenomenon of child development called "verbal irruption". In them we see the handling of symbols not only with signifiers, but also with associated meanings. With it he introduces and it will reduce the essential differential factor to current techniques and especially explicitly in future ones, in which both information formats will be handled at the same time so that in addition to the classic (significant) information allusion, the meaning of specific explicit information (from <meaning>, which is already done implicitly), and offers a greater understanding of the informative, phenomenal and autonomous expression (than the contextual one, that of formalized dictionaries, that of multimedia systems, or that requested from the Internet through search engines).

Regarding "for what" this study has been carried out

The problem model that solves how symbolic capacity works, aims to respond to a reproducibility of the symbolic process in restricted, but comparable, areas, ranging from the process of development of human language, to the one that also occurs in computer machines (with games such as chess or Go, as well as achievements such as the development of piloting an autonomous car, or the analysis of medical radiographs for diagnosis with a reliability superior to human).

It is shown how these achievements develop symbolic content processes using Bayesian expert systems (TD), as well as others of “sub-symbolic machine learning”, such as the BU symbolic process, for example with <deep learning>, supervised or unsupervised; for example, the last achievement winning human rivals in the game of Go, after having acquired the learning playing against himself (possible introduction of TD functionality), realizing with a breakthrough of skill in the unprecedented game.

The interaction of both modalities of AI establish methods that could emulate in their joint action (right diagram Scheme 1 on page 4, according to the theory of complexity), the essential reproduction of human symbolic capacity; All this has been exposed in a preliminary and restricted aspect, but which, from the point of view of that symbolic capacity, they suggest would be qualitatively complete in terms of complexity emulating humans (interactively with the WHAT x HOW).

We deduce that the computing machines of the immediate future will simultaneously combine strategies with programming techniques and hardware structures, which will allow functionalities of the TD and BU type based on complexity theory, which will be able to equalize access to human symbolic capacity. , and also expand it.

[46] Moreno, B. (2014). Revolution and stasis in nature. Notions of complexity. Website, Projects, INGIT.ES
Moreno, B. (2015). The iconic dimension. Website, Projects, INGIT.ES

Acronyms

BU: Bottom Up (from bottom to top)
GPU: Graphic Process Unit (released with Nvidia from 2012)
HD: right hemisphere
HI: left hemisphere
AI: artificial intelligence
OS: object or / and event origin of any symbolization, which have zero symbolization of itself, since it is the entity itself
RW: Rascorla and Wagner learning model
TD: Top Down

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